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Kim et al.

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(54) **DEVELOPING DEVICE AND IMAGE FORMING APPARATUS INCLUDING THE SAME**

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(30) **Foreign Application Priority Data**

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G03G 15/08 (2006.01)

(52) **U.S. Cl.**
CPC ***G03G 15/0889*** (2013.01); ***G03G 15/0808*** (2013.01); *G03G 15/0893* (2013.01)

(58) **Field of Classification Search**
USPC 399/254, 256, 263
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,860,437	B2 *	12/2010	Kakuta	G03G 15/0875 399/254
8,139,990	B2	3/2012	Okada et al.	
2013/0279941	A1 *	10/2013	Poterjoy	G03G 15/0889 399/254
2014/0056620	A1 *	2/2014	Hashimoto	G03G 15/0839 399/254

FOREIGN PATENT DOCUMENTS

JP	2007-041327	2/2007
JP	2008-191560	8/2008
JP	2009-300511	12/2009

* cited by examiner

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(57) **ABSTRACT**

A developing device includes: a photosensitive body on which an electrostatic latent image is formed; a development chamber; a development roller that faces the photosensitive body and transfers toner to the electrostatic latent image; a supply roller that supplies toner from the development chamber to the development roller; and an agitating member that is disposed under the supply roller in the development chamber and agitates the toner that is in the development chamber.

18 Claims, 8 Drawing Sheets

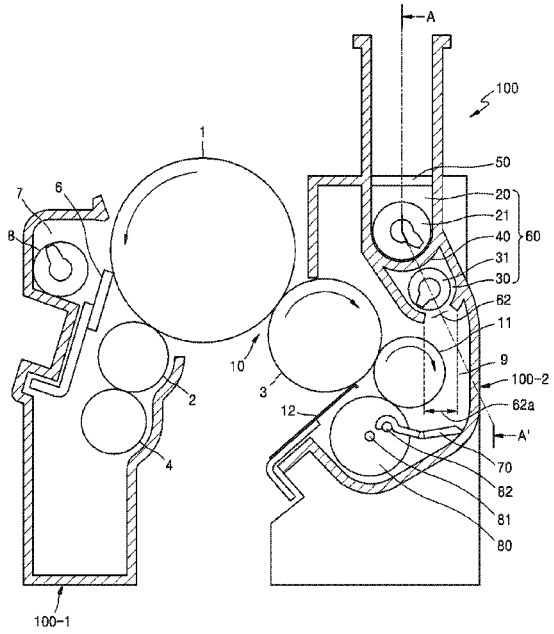


FIG. 1

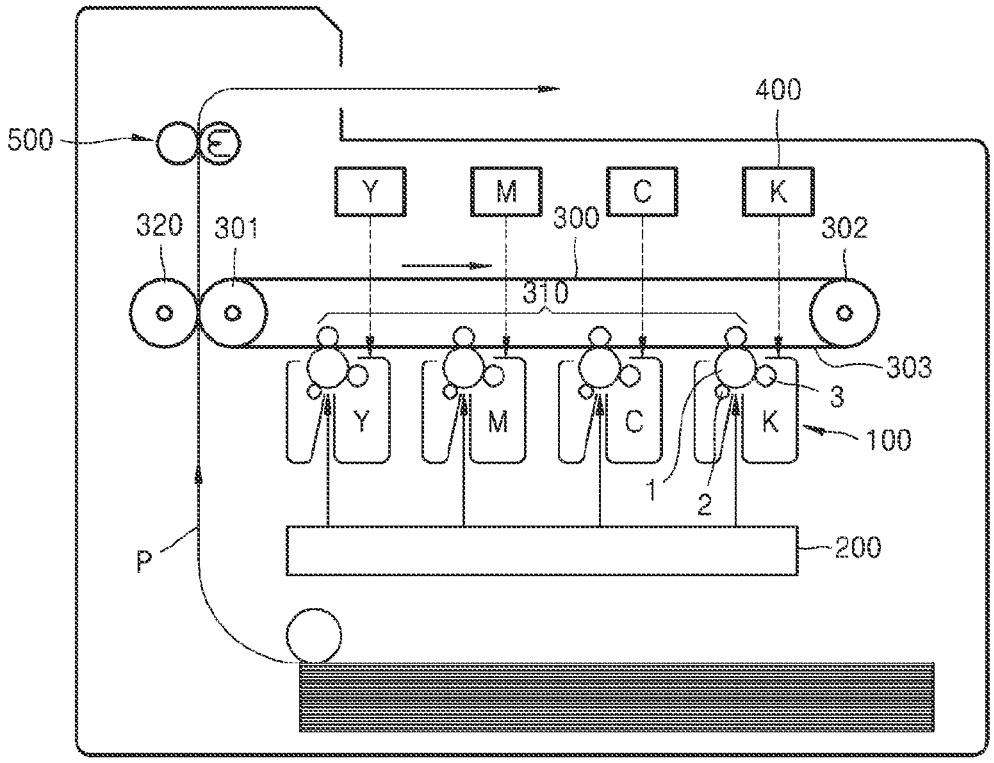
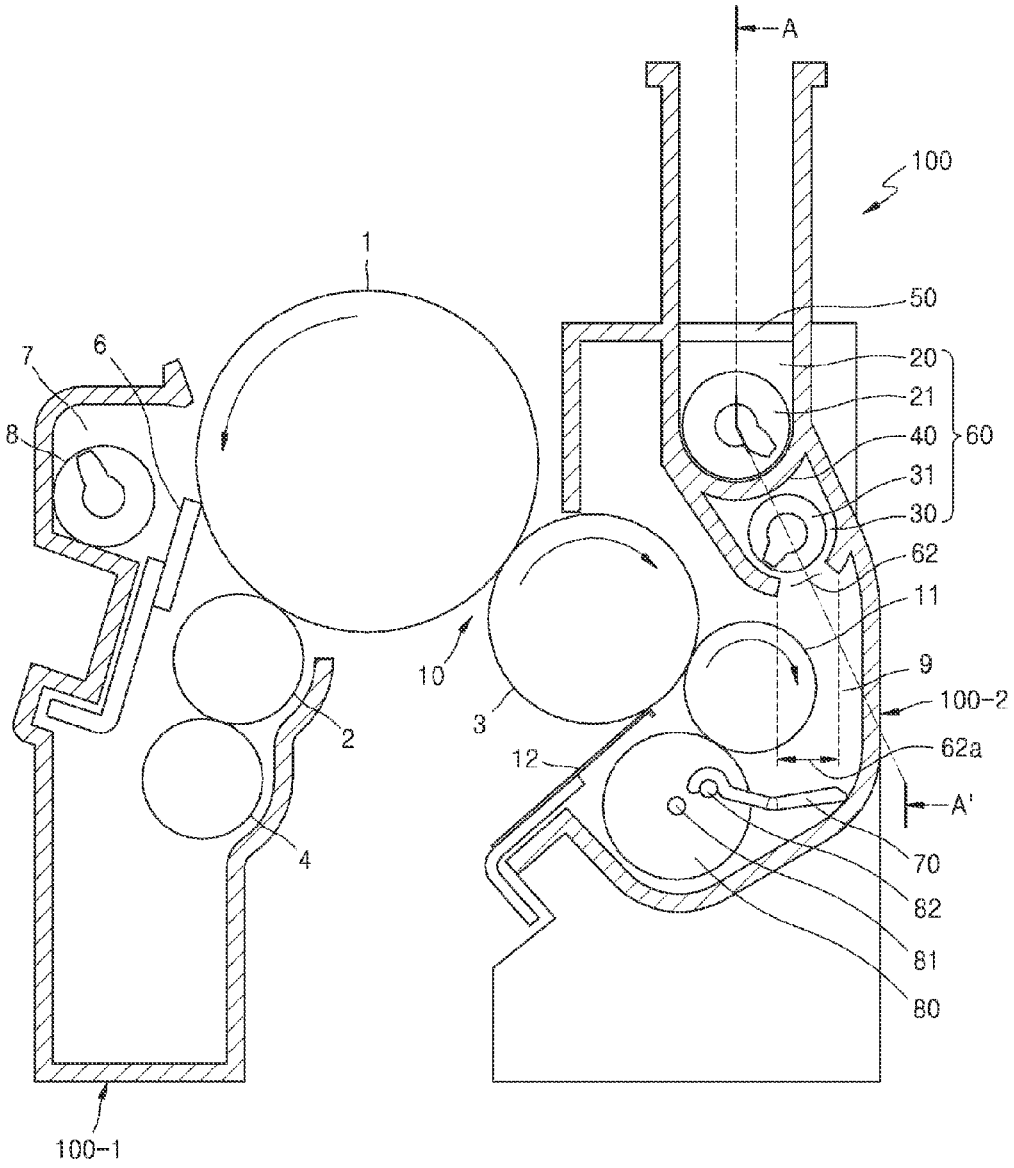


FIG. 2


A
100
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40
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62
11
9
100-2
62a
A'
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81
80
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6
8
10
3
12
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4
100-1

FIG. 3

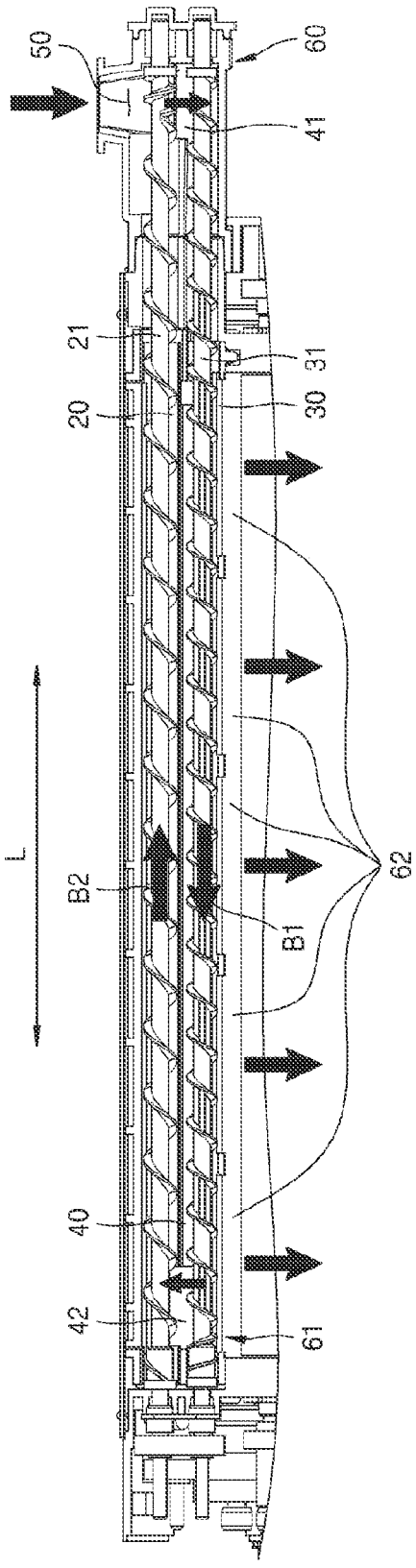


FIG. 4

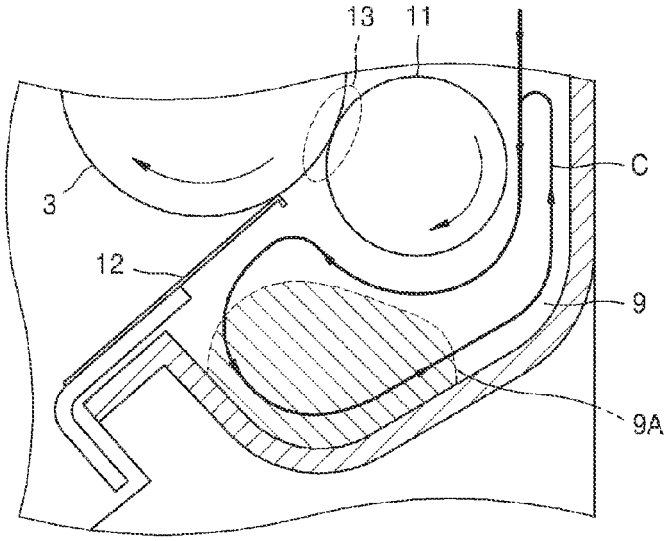


FIG. 5

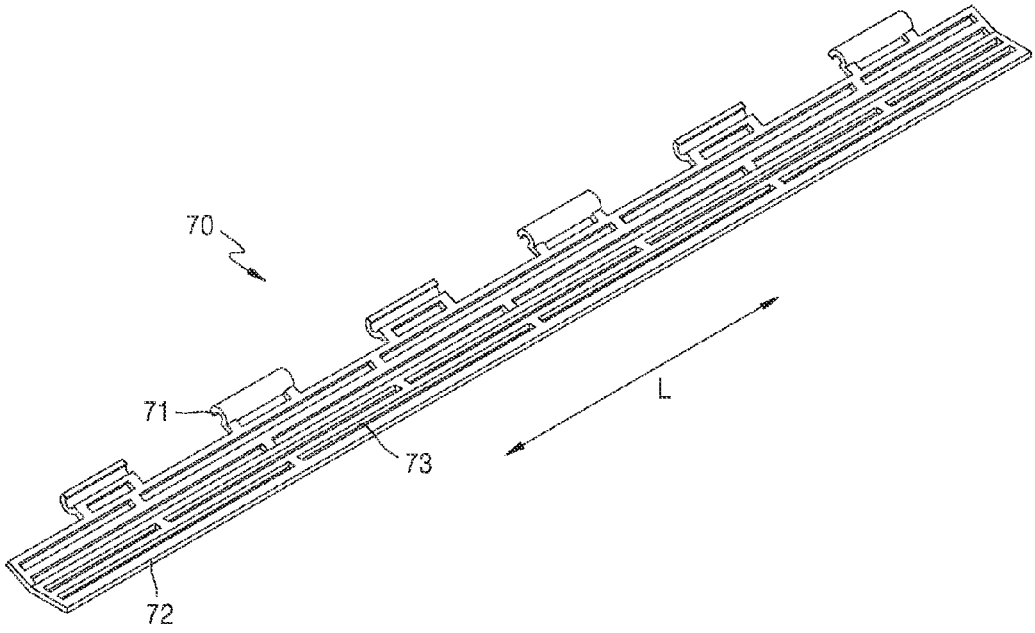


FIG. 6

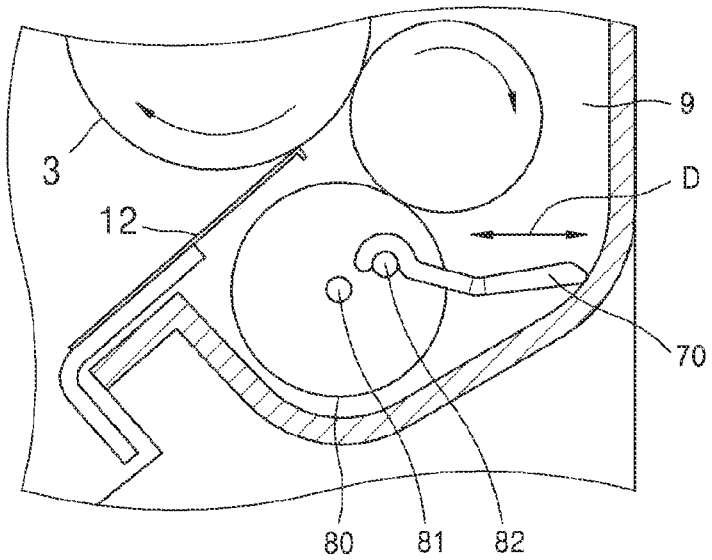


FIG. 7

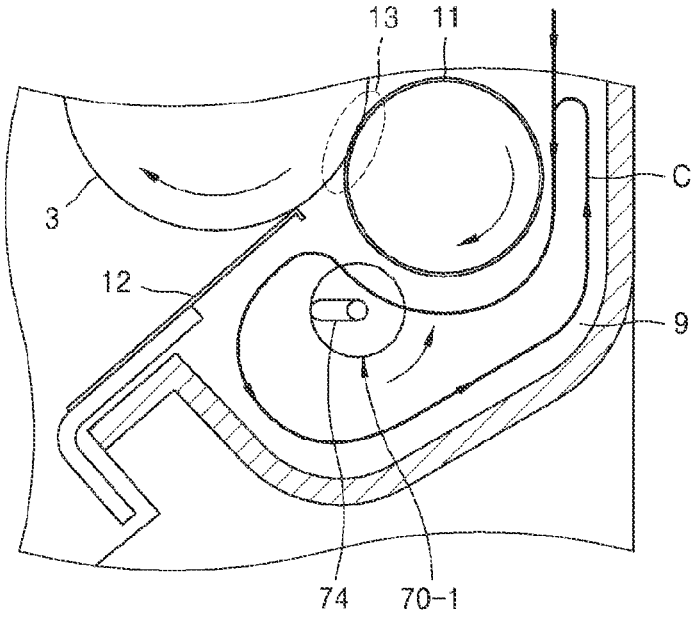


FIG. 8

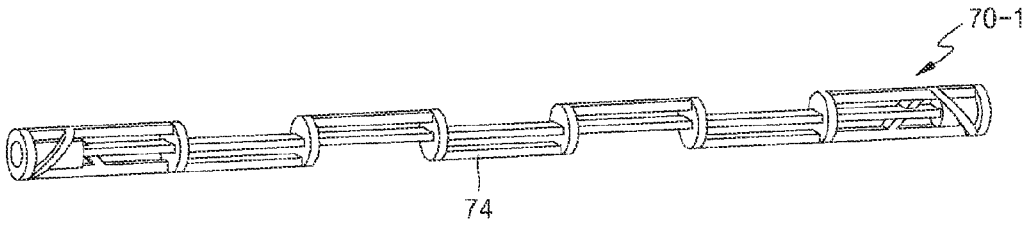


FIG. 9

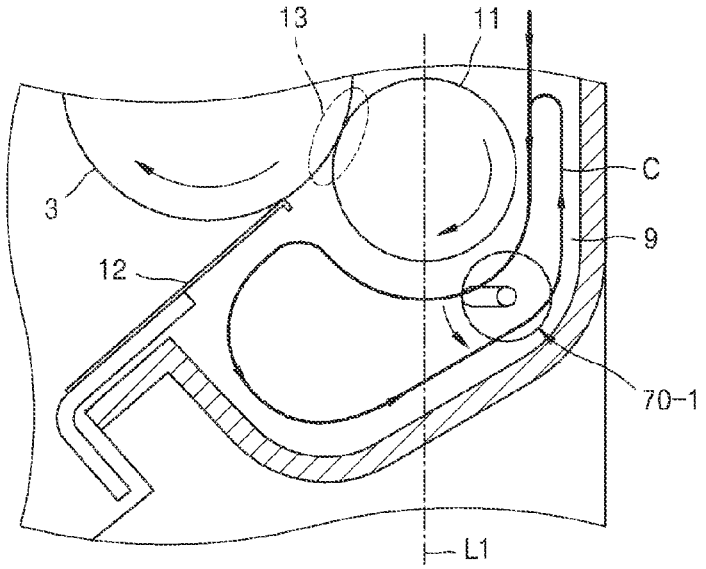


FIG. 10

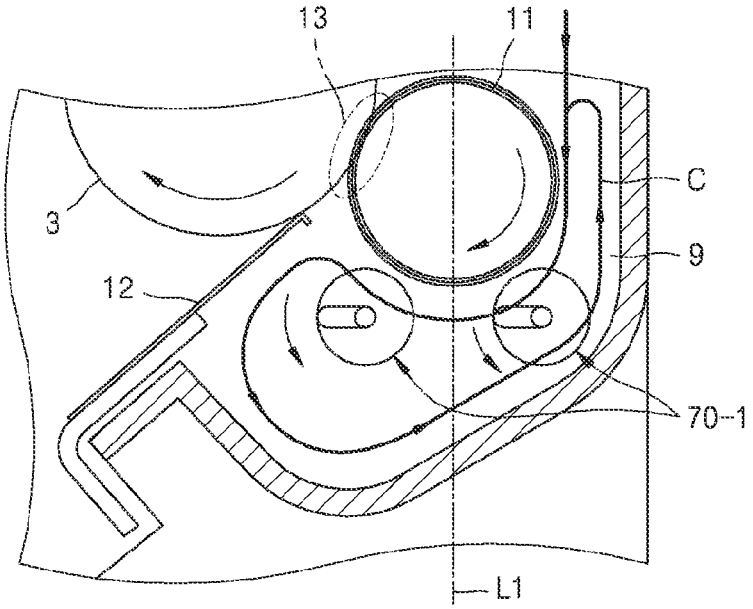


FIG. 11

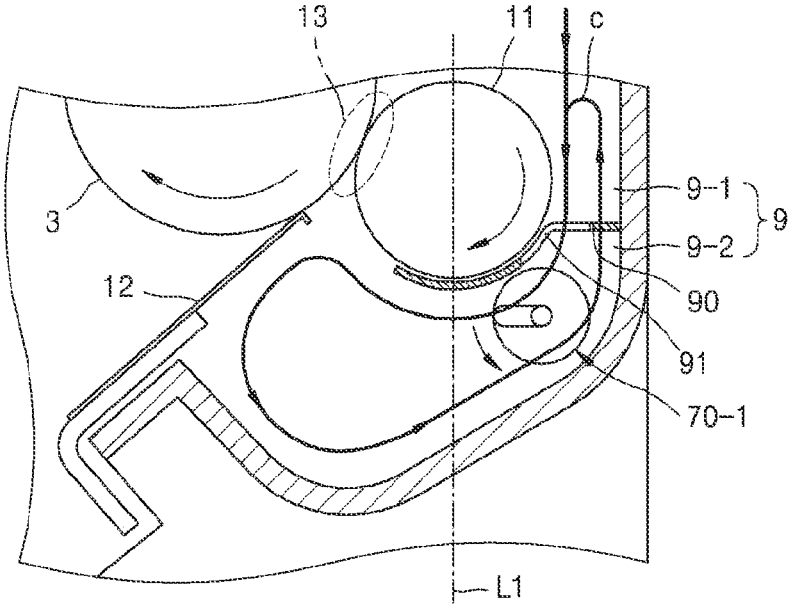


FIG. 12

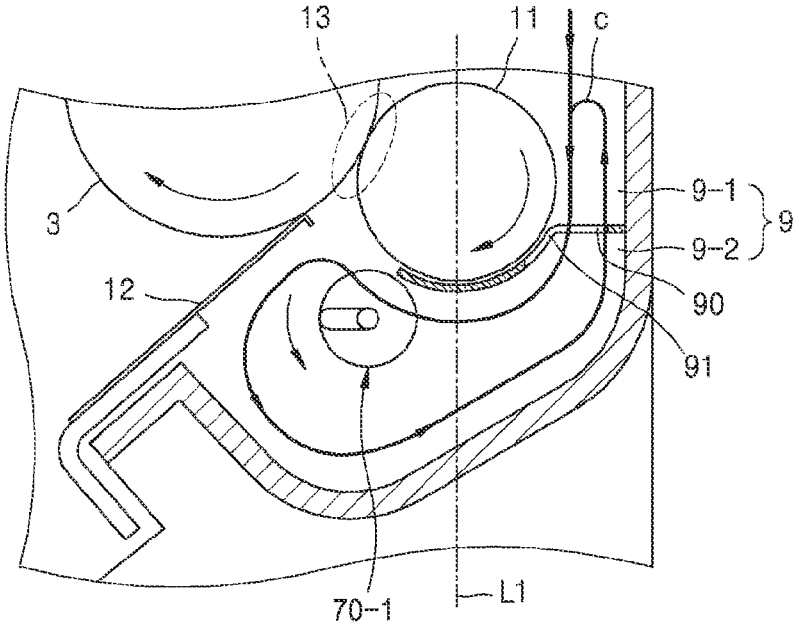
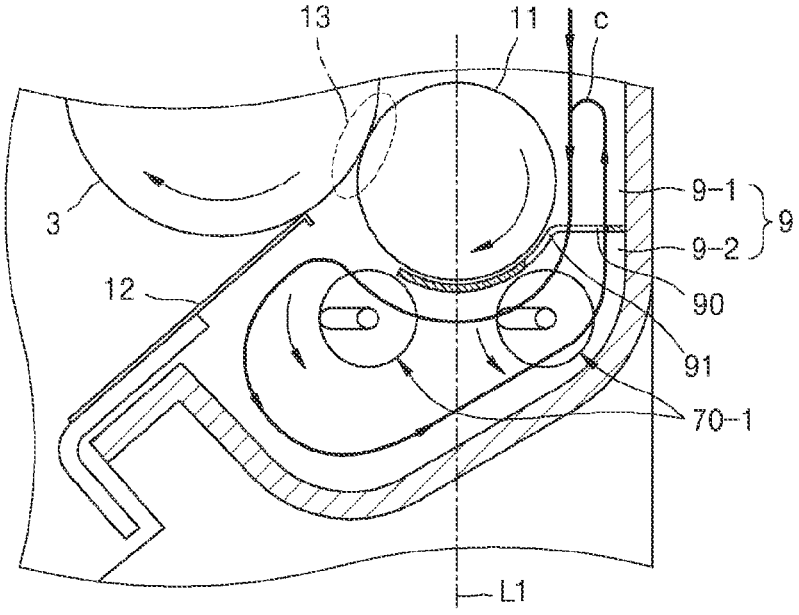


FIG. 13



DEVELOPING DEVICE AND IMAGE FORMING APPARATUS INCLUDING THE SAME

RELATED APPLICATION

This application claims the benefit under 35 U.S.C. §119 of Korean Patent Application No. 10-2014-0138609, filed Oct. 14, 2014, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference in its entirety.

BACKGROUND

1. Field

One or more example embodiments relate to a developing device that develops an electrostatic latent image and thereby produces a visible toner image, and an image forming apparatus including the developing device.

2. Description of the Related Art

An electrophotographic image forming apparatus forms an image on a recording medium by emitting light, which is modulated to correspond to image information, toward a photosensitive body to form an electrostatic latent image on a surface of the photosensitive body, supplying toner to the electrostatic latent image to develop the electrostatic latent image into a visible toner image, and transferring and fusing the visible toner image onto the recording medium.

A developing device supplies the toner to the electrostatic latent image that is formed on the surface of the photosensitive body to develop the electrostatic latent image into the visible toner image. The electrophotographic image forming apparatus includes the developing device, which includes a developing agent. Toner that is supplied from a toner container to the developing device passes through a development roller and is supplied to the photosensitive body. In the developing device, the toner that is supplied from the toner container and toner that is stored in the developing device have to circulate and be sequentially used for a developing process. If the toner that is stored in the developing device does not smoothly circulate, new toner may not be effectively supplied into the developing device. Also, if toner in a specific region of the developing device is continuously pressed without circulating, stress applied to the toner is increased, thereby degrading physical properties of the toner and increasing a driving torque of the developing device. Also, toner packing that is a phenomenon where toner lumps are formed in the specific region of the developing device may occur.

SUMMARY

One or more example embodiments include a developing device in which toner may smoothly circulate and an image forming apparatus including the developing device.

Additional aspects will be set forth in part in the description which follows and will be apparent from the description, or may be learned by practice of the presented example embodiments.

According to one or more example embodiments, a developing device includes: a photosensitive body on which an electrostatic latent image is formed; a development chamber; a development roller that faces the photosensitive body and transfers toner to the electrostatic latent image; a supply roller that supplies toner in the development chamber to the development roller; and an agitating member that is disposed under the supply roller in the development chamber and agitates the toner that is in the development chamber.

The agitating member may reciprocate in a direction perpendicular to a longitudinal axis of the development roller.

The developing device may further include a rotation member disposed in the development chamber and including an eccentric shaft that is eccentric with respect to a central axis about which the rotation member rotates, wherein the agitating member is connected to the eccentric shaft. The agitating member may include a connecting portion that is connected to the eccentric shaft and an agitating plate that extends from the connecting portion in the longitudinal direction and a radial direction, wherein the agitating plate includes a plurality of through-slots.

The agitating member may include an agitating blade, is provided in the development chamber, and rotates.

The developing device may include a guide member that divides the development chamber into an upper area and a lower area, extends toward the supply roller while at least partially surrounding a lower portion of the supply roller, wherein the agitating member includes an opening through which the upper area and the lower area communicate with each other. The agitating member may be disposed under the guide member.

The developing device may further include a toner supply unit that supplies toner to the development chamber by conveying the toner in a longitudinal direction that is an axial direction of the development roller, wherein the toner supply unit is disposed above the supply roller.

The toner supply unit may include: a supply portion comprising a supply member for conveying toner in a first direction and a supply hole for supplying toner to the development chamber; a retrieving portion disposed above the supply portion and comprising a retrieval member for conveying toner in a second direction that is opposite to the first direction; and a partition wall that separates the supply portion from the retrieving portion and includes first and second communication holes that are formed in two end portions of the partition wall in the longitudinal direction and through which the supply portion and the retrieving portion communicate with each other.

At least a part of a projection area of the supply hole in a gravity direction may overlap the supply roller.

According to one or more example embodiments, an electrophotographic image forming apparatus includes the developing device.

The electrophotographic image forming apparatus may further include a toner container that is connected to the development chamber and supplies toner to the development chamber.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects will become apparent and more readily appreciated from the following description of the example embodiments, taken in conjunction with the accompanying drawings in which:

FIG. **1** is a view illustrating a configuration of an image forming apparatus, according to an example embodiment;

FIG. **2** is a view illustrating a configuration of a developing device that is included in the image forming apparatus of FIG. **1**, according to an example embodiment;

FIG. **3** is a cross-sectional view taken along line A-A' of FIG. **2**, according to an example embodiment;

FIG. **4** is an illustration explaining how toner circulates in a development chamber;

FIG. **5** is a perspective illustrating an agitating member according to an example embodiment;

FIG. **6** is a cross-sectional view illustrating an operation of the agitating member of FIG. **5**, according to an example embodiment;

FIG. **7** is a cross-sectional view illustrating a development unit according to an example embodiment;

FIG. **8** is a perspective view illustrating an agitating member applied to the development unit of FIG. **7**, according to an example embodiment;

FIG. **9** is a cross-sectional view illustrating the development unit according to another example embodiment;

FIG. **10** is a cross-sectional view illustrating the development unit according to another example embodiment;

FIG. **11** is a cross-sectional view illustrating the development unit according to another example embodiment;

FIG. **12** is a cross-sectional view illustrating the development unit according to another example embodiment; and

FIG. **13** is a cross-sectional view illustrating the development unit according to another example embodiment.

DETAILED DESCRIPTION

Reference will now be made in detail to example embodiments, examples of which are illustrated in the accompanying drawings.

FIG. **1** is a view illustrating a configuration of an image forming apparatus, according to an example embodiment. The image forming apparatus of the present example embodiment is an electrophotographic color image forming apparatus that forms a color image by using four developing devices **100** in which cyan (C) toner, magenta (M) toner, yellow (Y) toner, and black (K) toner are contained. Members that are used to form C, M, Y, and K images are respectively denoted by reference numerals with subscripts C, M, Y, and K.

Referring to FIG. **1**, an intermediate transfer belt **300**, an exposure unit **200**, the four developing devices **100**, four intermediate transfer rollers **310**, a final transfer roller **320**, and a fuser unit **500** are illustrated.

The intermediate transfer belt **300** is an intermediate transfer medium which is supported by support rollers **301** and **302** and circulates. A toner image is temporarily transferred to the intermediate transfer belt **300** before being finally transferred to a recording medium P.

Each of the four developing devices **100** includes a charge roller **2**, a photosensitive drum **1**, and a development roller **3**. The photosensitive drum **1** is a photosensitive body on which an electrostatic latent image is formed. The photosensitive drum **1** may be obtained by forming a photosensitive layer having photoconductivity on an outer circumferential surface of a cylindrical metal pipe. The charge roller **2** is a charger for charging a surface of the photosensitive drum **1** to a uniform potential. A corona charger, instead of the charge roller **2**, may be used.

The exposure unit **200** forms the electrostatic latent image by emitting light that is modulated to correspond to image information to the photosensitive drum **1**. A light-emitting diode (LED) exposure unit that selectively turns on according to the image information a plurality of LEDs that are arranged in a main scanning direction may be used as the exposure unit **200**. Also, a laser scanning unit (LSU) that deflects a light emitted from a laser diode by using a light deflector such that the deflected light travels in the main scanning direction and scans the deflected light toward the photosensitive drum **1** may be used as the exposure unit **200**. The development roller **3** forms a toner image by attaching toner that is contained in the developing device **100** to the electrostatic latent image that is formed on the photosensitive drum **1**. Toner may be contained in the developing device **100** and may be supplied from a toner container **400** to the developing device **100**. When the toner that is contained in the toner container **400** is completely consumed, the toner container **400** may be replaced with a new one, independent of the developing device **100**.

Each of the four developing devices **100** is disposed such that the photosensitive drum **1** faces a bottom surface **303** of the intermediate transfer belt **300**. The photosensitive drum **1** may contact the bottom surface **303** of the intermediate transfer belt **300**. The intermediate transfer roller **310** is an intermediate transfer unit for transferring the toner image that is formed on the photosensitive drum **1** to the intermediate transfer belt **300**. The four intermediate transfer rollers **310** are disposed respectively above the four photosensitive drums **1** with the bottom surface **303** of the intermediate transfer belt **300** therebetween. An intermediate transfer bias voltage for transferring the toner image that is formed on the photosensitive drum **1** to the intermediate transfer belt **300** may be applied to each of the four intermediate transfer rollers **310**. A corona transfer unit, instead of the intermediate transfer roller **310**, may be used.

The final transfer roller **320** is a final transfer unit for transferring the toner image from the intermediate transfer belt **300** to the recording medium P. A final transfer bias voltage for transferring the toner image from the intermediate transfer belt **300** to the recording medium P may be applied to the final transfer roller **320**. A corona transfer unit, instead of the final transfer roller **320**, may be used. The fuser unit **500** fuses the toner image that is transferred to the recording medium P by applying heat and pressure to the toner image.

A method of forming a color image in the afore-described configuration will now be briefly explained.

First, the exposure unit **200** forms an electrostatic latent image by emitting light toward the photosensitive drum **1**K that is charged to a uniform potential by the charge roller **2**K, according to black (K) image information. When a development bias voltage is applied to the development roller **3**K of the developing device **100**K, black toner that is contained in the developing device **100**K is attached to the electrostatic latent image. A black toner image that is developed on the photosensitive drum **1**K is transferred to the intermediate transfer belt **300** due to an intermediate transfer bias voltage that is applied to the intermediate transfer roller **310**K. By using the same processes, cyan, magenta, and yellow toner images are transferred to the intermediate transfer belt **300** and a color toner image is formed on the intermediate transfer belt **300**. The color toner image is transferred to the recording medium P due to a final transfer bias voltage that is applied to the final transfer roller **320**, and is fused on the recording medium P by the fuser unit **500**.

FIG. **2** is a view illustrating a configuration of the developing device **100** that is included in the image forming apparatus of FIG. **1**, according to an example embodiment. Referring to FIG. **2**, the developing device **100** includes a photosensitive unit **100-1** and a development unit **100-2**.

The photosensitive unit **100-1** includes the photosensitive drum **1** and the charge roller **2**. A cleaning roller **4** contacts the charge roller **2**, and rotates and removes a foreign material that is attached to a surface of the charge roller **2**. A cleaning blade **6** removes residual toner that remains on a surface of the photosensitive drum **1** after a transferring process. The removed residual toner is referred to as waste toner. The waste toner may be stored in a waste toner

receiving space **7** in the photosensitive unit **100-1**, and may be conveyed to a waste toner container (not shown) by a waste toner conveying member **8**.

The development unit **100-2** includes a development chamber **9**, and the development roller **3** that carries toner that is contained in the development chamber **9** to a development area **10** where the development roller **3** and the photosensitive drum **1** face each other. A supply roller **11** contacts the development roller **3** and rotates. A supply bias voltage is applied to the supply roller **11**, and a development bias voltage is applied to the development roller **3**. A supply electric field is formed between the supply roller **11** and the development roller **3** due to the supply bias voltage and the development bias voltage. As the supply roller **11** rotates, toner that is carried to the development roller **3** by the supply roller **11** is attached to a surface of the development roller **3** due to the supply electric field.

A regulation member **12** that regulates the amount of toner attached to the surface of the development roller **3** is disposed downstream of the supply roller **11** in a direction in which the development roller **3** rotates. For example, the regulation member **12** may be a blade that elastically contacts the surface of the development roller **3**. A toner layer having a uniform thickness is formed on the surface of the development roller **3** due to the regulation member **12**. Toner is charged due to friction between the development roller **3** and the regulation member **12**. A bias voltage for charging the toner may be applied to the regulation member **12**.

As the development roller **3** rotates, the toner on the surface of the development roller **3** is carried to the development area **10** where the development roller **3** and the photosensitive drum **1** face each other. A development electric field is formed in the development area **10** due to the development bias voltage. The toner is moved from the surface of the development roller **3** to the surface of the photosensitive drum **1** and is attached to the surface of the photosensitive drum **1** due to the development electric field. Accordingly, an electrostatic latent image that is formed on the surface of the photosensitive drum **1** is developed and thus a visible toner image is produced.

Toner is supplied from the toner container **400** to the development unit **100-2**. A toner supply unit **60** that receives the toner from the toner container **400** and supplies the toner to the development chamber **9** is provided in the development unit **100-2**. In order to naturally supply the toner from the toner container **60** to the development chamber **9** due to gravity, the toner supply unit **60** is disposed above the development chamber **9**. Also, in order to supply fresh toner from the toner supply unit **60** to the supply roller **11**, the toner supply unit **60** is disposed above the supply roller **11**.

FIG. **3** is a cross-sectional view taken along line A-A' of FIG. **2**, according to an example embodiment. Referring to FIGS. **2** and **3**, the toner supply unit **60** extends in a longitudinal direction L. The longitudinal direction L is a width direction of the recording medium P, that is, an axial direction of the development roller **3** and the supply roller **11**. The toner supply unit **60** includes a toner inlet portion **50**, a supply portion **30**, and a retrieving portion **20**. The retrieving portion **20** is disposed above the supply portion **30**. The supply portion **30** is disposed above the supply roller **11**.

The supply portion **30** and the retrieving portion **20** are separated from each other by a partition wall **40** that extends in the longitudinal direction L. A first communication hole **41** is formed in one end portion of the partition wall **40** in the longitudinal direction L. Also, a second communication hole **42** is formed in the other end portion of the partition wall **40** in the longitudinal direction L. The supply portion **30** and the retrieving portion **20** are connected to each other through the first and second communication holes **41** and **42**. The toner inlet portion **50** is disposed near one end portion of each of the supply portion **30** and the retrieving portion **20** in the longitudinal direction L, that is near the first communication hole **41**.

A supply member **31** that agitates toner and conveys the toner in a first direction B**1**, that is, from the first communication hole **41** to the second communication hole **42**, is disposed in the supply portion **30**. The supply member **31** may include, for example, an auger including a spiral wing. A retrieval member **21** that conveys toner in a second direction B**2**, that is, from the second communication hole **42** to the first communication hole **41**, is disposed in the retrieving portion **20**. The retrieval member **21** may include, for example, an auger including a spiral wing.

Toner that is supplied from the toner container **400** to the toner inlet portion **50** is conveyed in the first direction B**1** along the supply portion **30** by the supply member **31**. Supply holes **62** are formed in a bottom surface of a housing **61** that defines the supply portion **30**. The toner that is conveyed in the first direction B**1** along the supply portion **30** drops into the development chamber **9** through the supply holes **62**. The toner may directly drop onto the supply roller **11**. That is, at least a part of a projection area **62***a* of each of the supply holes **62** in a gravity direction overlaps the supply roller **11**. Accordingly, fresh toner may be effectively supplied through the supply roller **11** to the development roller **3**.

When toner that is conveyed along the supply portion **30** reaches around the second communication hole **42**, the toner is pushed by a feed force of the supply member **31** to be introduced through the second communication hole **42** into the retrieving portion **20**. The retrieval member **21** conveys the toner that is introduced through the second communication hole **42** in the second direction B**2**. When the toner reaches the first communication hole **41**, the toner naturally drops into the supply portion **30** due to its weight. In this case, new toner that is supplied from the toner container **400** is mixed with toner that circulates in the toner supply unit **60**. In this configuration, toner circulates in the toner supply unit **60** and is supplied to the development chamber **9**.

Toner is naturally supplied from the toner supply unit **60** to the development chamber **9** due to gravity. Once the development chamber **9** is filled with toner, toner is no longer supplied from the toner supply unit **60** to the development chamber **9**, and toner remaining in the toner supply unit **60** circulates in the supply portion **30** and the retrieving portion **20**.

FIG. **4** is a view illustrating how toner circulates in a development chamber **9**. Referring to FIG. **4**, as the supply roller **11** rotates, a portion of the toner that is supplied from the toner supply unit **60** into the development chamber **9** is conveyed to a supply area **13** where the development roller **3** and the supply roller **11** face each other. A portion of the toner is attached to the development roller **3** due to an electric field that is formed between the development roller **3** and the supply roller **11**. The remainder of the toner, which is not attached to the development roller **3** in the supply area **13**, drops into the development chamber **9** due to the weight thereof. The regulation member **12** regulates a toner layer on a surface of the development roller **3**. Accordingly, any excess toner attached to the development roller **3** is removed from the surface of the development roller **3** by the regulation member **12** and drops into the development chamber **9**. The toner that drops into the development chamber **9**

accumulates in a lower portion **9**A of the development chamber **9** under the supply roller **11**. Once the development chamber **9** is filled with the toner, the toner is conveyed to the toner supply unit **60** in a direction marked by an arrow C of FIG. **4** and then is mixed with new toner that is supplied from the toner supply unit **60** and repeatedly circulates as described above.

When toner continuously accumulates in the lower portion **9**A under the supply roller **11**, pressure applied to the toner in the lower portion **9**A increases. Accordingly, the amount of toner that is supplied from the toner supply unit **60** to the lower portion **9**A is much greater than the amount of toner that is moved upward from the lower portion **9**A to the tonner supply unit **60**, and the toner is continuously compressed in the lower portion **9**A, thereby leading to toner packing.

When the toner does not circulate in the lower portion **9**A, the toner in the lower portion **9**A stays in the development chamber **9** until the end of a lifespan of the developing device **100**, and only toner that is supplied from the toner supply unit **60** to a space around the supply roller **11** is continuously attached through the development area **10** to the photosensitive drum **1** to be developed. Also, as toner having a smaller diameter and a shape closer to a spherical shape tends to be more easily developed, at the end of the lifespan of the developing device **100**, only toner having a large diameter and a poor spherical shape remains in the development chamber **9**. Since the toner having a large diameter and a poor spherical shape has poor development performance, the quality of an image that is formed at the end of the lifespan of the developing device **100** may be worse than that of an image that is formed at the beginning of the lifespan of the developing device **100**. Also, when the toner in the lower portion **9**A does not circulate, the toner is continuously compressed due to gravity and a toner feed force that is produced as the supply roller **11** rotates, thereby leading to toner packing that is a phenomenon where toner lumps are formed. Once the toner packing occurs, rolling resistance is applied to the supply roller **11** and the development roller **3** that rotate in the development chamber **9**, thereby increasing a driving torque.

Referring to FIG. **2**, the developing device **100** of the present example embodiment includes an agitating member **70** that is disposed in the lower portion **9**A of the development chamber **9** and agitates toner in order to prevent the toner from staying. The agitating member **70** causes the toner to flow in the development chamber **9**. The agitating member **70** agitates the toner in the development chamber **9** in a direction that crosses the longitudinal direction L.

FIG. **5** is a perspective view illustrating the agitating member **70** according to an example embodiment. FIG. **6** is a cross-sectional view for explaining an operation of the agitating member **70** of FIG. **5**, according to an example embodiment. Referring to FIGS. **2**, **4**, **5**, and **6**, the agitating member **70** reciprocates toner in the lower portion **9**A in a direction D that is perpendicular to the longitudinal direction L. To this end, a rotation member **80** is provided in the development chamber **9**. The agitating member **70** is connected to an eccentric shaft **82** that is eccentric from a central axis **81** of the rotation member **80**. When the rotation member **80** rotates, the agitating member **70** reciprocates in the direction D that is perpendicular to the longitudinal direction L. The agitating member **70** may include a connecting portion **71** that is connected to the eccentric shaft **82** of the rotation member **80** and an agitating plate **72** that extends in the longitudinal direction L and a radial direction from the connecting portion **71**. A plurality of through-slots **73** may be formed in the agitating plate **72**. Due to the slots **73**, the agitating member **70** may more efficiently agitate toner and thus cause the toner to flow.

When the toner begins to flow due to the reciprocation of the agitating member **70**, toner lumps may be prevented from forming in the lower portion **9**A. Accordingly, the toner naturally circulates in the development chamber **9** in the direction marked by the arrow C of FIG. **4** due to a toner feed force that is produced due to the rotation of the supply roller **11**.

In this configuration, new toner whose amount corresponds to the amount of toner that circulates in the development chamber **9** and is attached to the photosensitive drum **1** to be developed is supplied from the toner supply unit **60** to the development chamber **9**. Accordingly, toner may be continuously mixed with new toner in the development chamber **9**. Also, since a constant toner pressure is maintained in the development chamber **9** without excessively increasing, stress applied to toner is also reduced. Accordingly, physical properties of toner are stably maintained uniform until the end of the lifespan of the developing device **100** and a printed image having stable quality may be obtained until the end of the lifespan of the developing device **100**. Also, since toner packing does not occur, a driving torque of the developing device **100** may be maintained at a stable level until the end of the lifespan of the developing device **100**.

Although the agitating member **70** that reciprocates in the direction D that is perpendicular to the longitudinal direction L is used in the above example embodiments, the inventive concept is not limited thereto. Any of various agitating members that may cause toner to flow by agitating the toner in the development chamber **9** may be used.

FIG. **7** is a cross-sectional view illustrating the development unit **100-2** according to an example embodiment. FIG. **8** is a perspective view illustrating an agitating member **70-1** applied to the development unit **100-2** of FIG. **7**, according to an example embodiment. Referring to FIGS. **7** and **8**, the agitating member **70-1** that rotates is disposed in the lower portion **9**A of the development chamber **9** under the supply roller **11**. The agitating member **70-1** that is disposed under the supply roller **11** and extends in the longitudinal direction L to be parallel to the supply roller **11** includes an agitating blade **74** that extends in the radial direction. The agitating member **70-1** is disposed under the supply area **13** where the development roller **4** and the supply roller **11** face each other. When the agitating member **70-1** rotates, the agitating blade **74** agitates toner in the development chamber **9** and thus causes the toner to flow in the development chamber **9**. The toner may circulate in the development chamber **9** in a direction marked by an arrow C. A direction in which the agitating member **70-1** rotates may be opposite to a direction in which the supply roller **11** rotates. Accordingly, the toner may be more easily conveyed to the toner supply unit **60**.

A position of the agitating member **70-1** is not limited to that in FIG. **7**. The agitating member **70-1** may be disposed at any position in the development chamber **9**, as long as the agitating member **70-1** is disposed under the supply roller **11**

FIG. **9** is a cross-sectional view illustrating the development unit **100-2** according to another example embodiment. Referring to FIG. **9**, the agitating member **70-1** is disposed under the supply roller **11** so that the agitating member **70-1** and the supply area **13** are on opposite sides of a vertical line L**1** that passes through the center of the supply roller **11**. Even in this configuration, since toner in the development chamber **9** flows due to rotation of the agitating member **70-1**, the toner may circulate in the development chamber **9**

in the direction marked by the arrow C. A direction in which the agitating member **70-1** rotates may be opposite to a direction in which the supply roller **11** rotates.

A plurality of the agitating members **70-1** may be disposed. FIG. **10** is a cross-sectional view illustrating the development unit **100-2** according to another example embodiment. Referring to FIG. **10**, the agitating members **70-1** are disposed under the supply roller **11** in the development chamber **9** to be located on both sides of the straight line L**1** that passes through the center of the supply roller **11**. A direction in which the agitating members **70-1** rotate may be opposite to a direction in which the supply roller **11** rotates.

FIG. **11** is a cross-sectional view illustrating the development unit **100-2** according to another example embodiment. Referring to FIG. **11**, a guide member **90** is disposed between the agitating member **70-1** and the supply roller **11**. The guide member **90** divides the development chamber **9** into a lower area **9-2** and an upper area **9-1** with respect to the supply roller **11** and extends toward the supply area **13** while at least partially surrounding a lower portion of the supply roller **11**. An opening **91** through which toner in the lower area **9-2** is conveyed to the upper area **9-1** is formed in the guide member **90**. In this configuration, a supply force of the supply roller **11** that conveys toner to the supply area **13** may be increased. When toner around the supply roller **11** is conveyed to the supply area **13** due to rotation of the supply roller **11**, a strong supply force of the supply roller **11** is applied to a gap between the guide member **90** and the supply roller **11**. Accordingly, toner that is supplied from the upper area **9-1** may be effectively conveyed to the supply area **13** without being mixed with toner in the lower area **9-2**. The toner in the lower area **9-2** is conveyed to the upper area **9-1** through the opening **91** as the agitating member **70-1** rotates.

The guide member **90** may be applied to the development unit **100-2** of FIG. **7**. FIG. **12** is a cross-sectional view illustrating the development unit **100-2** according to another example embodiment. Referring to FIG. **12**, the agitating member **70-1** is disposed under the supply area **13** where the development roller **3** and the supply roller **11** face each other. The guide member **90** is disposed between the agitating member **70-1** and the supply roller **11**. The guide member **90** divides the development chamber **9** into the lower area **9-2** and the upper area **9-1** with respect to the supply roller **11** and extends to the supply area **13** while at least partially surrounding a lower portion of the supply roller **11**. The opening **91** through which toner in the lower area **9-2** is conveyed to the upper area **9-1** is formed in the guide member **90**.

The guide member **90** may be applied to the development unit **100-2** of FIG. **10**. FIG. **13** is a cross-sectional view illustrating the development unit **100-2** according to another example embodiment. Referring to FIG. **13**, the agitating members **70-1** are disposed under the supply roller **11** in the development chamber **9** to be located on both sides of the vertical line L**1** that passes through the center of the supply roller **11**.

The guide member **90** is disposed between the agitating members **70-1** and the supply roller **11** to divide the development chamber **9** into the lower area **9-2** and the upper area **9-1** with respect to the supply roller **11** and to extend to the supply area **13** and overlap a lower portion of the supply roller **11**. The opening **91** through which toner in the lower portion **9-2** is conveyed to the upper area **9-1** is formed in the guide member **90**.

Although not shown in FIG. **13**, the guide member **90** may be applied to the development chamber **9** that includes the reciprocating type agitating member **70** of FIG. **2** that reciprocates.

Although a color image forming apparatus has been explained in the above example embodiments, the inventive concept is not limited thereto. The inventive concept may be applied to a monochromatic image forming apparatus that includes one developing device **100** and transfers to the recording medium P a visible toner image that is formed on the photosensitive drum **1**.

While the inventive concept has been particularly shown and described with reference to example embodiments thereof, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the inventive concept as defined by the following claims.

What is claimed is:

1. A developing device comprising:
- a photosensitive body on which an electrostatic latent image is formed;
- a development chamber;
- a development roller that faces the photosensitive body and transfers toner to the electrostatic latent image;
- a supply roller that supplies toner in the development chamber to the development roller;
- an agitating member disposed under the supply roller in the development chamber, said agitating member being arranged to agitate the toner that is in the development chamber; and
- a toner supply unit that supplies the toner to the development chamber by conveying the toner in a longitudinal direction that is an axial direction of the development roller,
- wherein
- the toner supply unit is disposed above the supply roller,
- the toner supply unit comprises a supply hole through which the toner conveyed in the longitudinal direction drops into the development chamber, and
- at least a part of a projection of the supply hole in a gravity direction overlaps the supply roller.

2. The developing device of claim **1**, wherein the agitating member arranged to reciprocate in a direction perpendicular to a longitudinal axis of the development roller.

3. The developing device of claim **2**, further comprising:
- a rotation member disposed in the development chamber, said rotation member comprising an eccentric shaft that is eccentric with respect to a central axis about which the rotation member rotates,
- wherein the agitating member is connected to the eccentric shaft.

4. The developing device of claim **3**, wherein the agitating member comprises a connecting portion that is connected to the eccentric shaft and an agitating plate that extends from the connecting portion in the longitudinal direction and in a radial direction,
- wherein the agitating plate comprises a plurality of through-slots.

5. The developing device of claim **1**, wherein the agitating member comprises an agitating blade provided in the development chamber, said agitating member being arranged to rotate.

6. The developing device of claim **1**, further comprising a guide member that divides the development chamber into an upper area and a lower area, said guide member extending toward the supply roller and at least partially surrounding a lower portion of the supply roller,

wherein the guide member includes an opening through which the upper area and the lower area communicate with each other.

7. The developing device of claim 6, wherein the agitating member is disposed under the guide member.

8. A developing device comprising:

a photosensitive body on which an electrostatic latent image is formed;

a development chamber;

a development roller that faces the photosensitive body and transfers toner to the electrostatic latent image;

a supply roller that supplies toner in the development chamber to the development roller;

an agitating member disposed under the supply roller in the development chamber, said agitating member being arranged to agitate the toner that is in the development chamber;

a toner supply unit that supplies toner to the development chamber by conveying the toner in a longitudinal direction that is an axial direction of the development roller, wherein the toner supply unit is disposed above the supply roller; and

wherein the toner supply unit comprises:

a supply portion comprising a supply member for conveying toner in a first direction and a supply hole for supplying toner to the development chamber;

a retrieving portion disposed above the supply portion and comprising a retrieval member for conveying toner in a second direction that is opposite to the first direction; and

a partition wall that separates the supply portion from the retrieving portion and includes first and second communication holes that are formed in first and second end portions respectively of the partition wall in the longitudinal direction and through which the supply portion and the retrieving portion communicate with each other.

9. The developing device of claim 8, wherein at least a part of a projection of the supply hole in a gravity direction overlaps the supply roller.

10. An electrophotographic image forming apparatus comprising a developing device, wherein the developing device comprises:

a photosensitive body on which an electrostatic latent image is formed;

a development chamber;

a development roller that faces the photosensitive body and transfers toner to the electrostatic latent image;

a supply roller that supplies toner in the development chamber to the development roller;

an agitating member disposed under the supply roller in the development chamber, said agitating member being arranged to agitate the toner that is in the development chamber; and

a toner supply unit that supplies toner to the development chamber by conveying the toner in a longitudinal direction that is an axial direction of the development roller,

wherein

the toner supply unit is disposed above the supply roller,

the toner supply unit comprises a supply hole through which the toner conveyed in the longitudinal direction drops into the development chamber, and

at least a part of a proiection of the supply hole in a gravity direction overlaps the supply roller.

11. The electrophotographic image forming apparatus of claim 10, wherein the agitating member is arranged to reciprocate in a direction perpendicular to a longitudinal axis of the development roller.

12. The electrophotographic image forming apparatus of claim 11, further comprising:

a rotation member disposed in the development chamber, said rotation member comprising an eccentric shaft that is eccentric with respect to a central axis about which the rotation member rotates,

wherein the agitating member is connected to the eccentric shaft.

13. The electrophotographic image forming apparatus of claim 12, wherein the agitating member comprises a connecting portion that is connected to the eccentric shaft and an agitating plate that extends from the connecting portion in the longitudinal direction and in a radial direction,

wherein the agitating plate comprises a plurality of through-slots.

14. The electrophotographic image forming apparatus of claim 10, wherein the agitating member comprises an agitating blade provided in the development chamber, said agitating member being arranged to rotate.

15. The electrophotographic image forming apparatus of claim 10, further comprising a guide member that divides the development chamber into an upper area and a lower area, said guide member extending toward the supply roller and at least partially surrounding a lower portion of the supply roller,

wherein the guide member includes an opening through which the upper area and the lower area communicate with each other.

16. The electrophotographic image forming apparatus of claim 10, further comprising a toner container that is connected to the development chamber via the toner supply unit and supplies toner to the development chamber.

17. An electrophotographic image forming apparatus comprising a developing device, wherein the developing device comprises:

a photosensitive body on which an electrostatic latent image is formed;

a development chamber;

a development roller that faces the photosensitive body and transfers toner to the electrostatic latent image;

a supply roller that supplies toner in the development chamber to the development roller;

an agitating member disposed under the supply roller in the development chamber, said agitating member being arranged to agitate the toner that is in the development chamber;

a toner supply unit that supplies toner to the development chamber by conveying the toner in a longitudinal direction that is an axial direction of the development roller, wherein the toner supply unit is disposed above the supply roller; and

wherein the toner supply unit comprises:

a supply portion comprising a supply member for conveying toner in a first direction and a supply hole for supplying toner to the development chamber;

a retrieving portion disposed above the supply portion and comprising a retrieval member for conveying toner in a second direction that is opposite to the first direction; and

a partition wall that separates the supply portion from the retrieving portion, and includes first and second communication holes that are formed in first and second end portions respectively of the partition wall in the

longitudinal direction and through which the supply portion and the retrieving portion communicate with each other.

18. The electrophotographic image forming apparatus of claim **17**, wherein at least a part of a projection of the supply hole overlaps the supply roller.

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